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XX. ON THE READING AND MEMORIZING OF MEANINGLESS SYLLABLES PRESENTED AT IRREGULAR TIME INTERVALS.

By MARGARET K. SMITH, Ph. D.

The natural tendency to read disconnected syllables in rhythmic groups and the comparative ease of memorizing rhythmic material are matters of common observation. In the laboratory studies made with meaningless syllables, it has been found practically impossible to avoid metrical groupings even when the syllables themselves are presented in strictly uniform series. A subjective tendency toward grouping forces upon them a metrical form which does not exist in their objective arrangement. During the writer's experiments upon Rhythm and Work¹ certain tests were made with the reading of meaningless syllables, in the course of which the question arose as to the extent to which objective inequalities may exist and a rhythmic grouping still be maintained, and, as a secondary question, what the rhythm secured under such difficulties signifies to the individual.

With a view to answering the above questions in connection with voice rhythm, at least, a series of experiments was made in the Psychological Laboratory at Clark University, Worcester, Mass., in the winter of 1900-1901, and though the experiments were unsuccessful as regards finding any order of syllables so irregular as to be wholly refractory to the rhythmic impulse of all the subjects, it seems worth while to give a brief account of them²

¹Rhythmus und Arbeit: Wundt's *Philos. Studien*, Bd. XVI, 1900, 71-133.

²The work was under the general direction of Professor Sanford, to whom and to President Hall, the writer wishes to express her sincere thanks for many helpful suggestions, as well as for the many privileges of the laboratories, the library, etc.

I. APPARATUS AND METHOD.

The material consisted of meaningless syllables, while the procedure consisted in reading aloud these syllables as they appeared at irregular intervals on a horizontal rotating cylinder, similar to that of the Baltzar kymograph. The cylinder was 25 inches in circumference and 13 inches long, and was turned by an electric motor (acting through various retarding mechanisms) which caused it to rotate at the rate of one revolution in nine seconds. The syllables were constructed according to the general rules for the Ebbinghaus-Müller syllables¹ but as the peculiarities of English vowels and diphthongs do not admit of an arrangement identical with that of German syllables, the construction of the English syllables underwent some unimportant modifications. The chief aim was to secure syllables which were not suggestive one of the other, and which were as little as possible liable to suggest any associations whatever. These syllables were written in vertical columns (twelve in a column), on twelve strips of paper (four columns on a strip) which were fastened as required, on the cylinder above mentioned. A screen was placed in front of the rotating cylinder. The subject sat on a chair before it, and through an opening in the screen on a level with the eyes, he read each syllable as it moved past. Before beginning with the chief series, the syllables of which were written at unequal intervals, each subject read and learned four series of syllables written at equal intervals (1.75 inches). In reading these syllables the subject invariably fell into one of the four common verse rhythms. In all the other series, the syllables were arranged at unequal distances from one another. Though the intervals were not the same on any two papers, a description of one paper may give an idea of all.

First Paper.

Distance between the 1st and 2nd syllables, 2.625 inches.

Distance between the 2nd and 3rd syllables, 1.75 inches.

Distance between the 3rd and 4th syllables, 0.875 inches.

These distances, representing 3, 2 and 1 units respectively, were repeated until twelve syllables had been written in a column. Here of course we have not absolute irregularity, but rather a complex rhythm. On the second paper, the intervals were again in the ratio of 3, 2, 1, but were repeated more irregularly. On the third paper, the arrangement of intervals

¹Ebbinghaus: Ueber das Gedächtnis, Leipzig, 1885.

Müller u. Schumann.

Müller u. Schumann: Experimentelle Beiträge zur Untersuchung des Gedächtnisses, Leipzig, 1893.

was again still more irregular, the distances varying from .625 of an inch to 5 inches. Care was always taken to keep such a distance between the syllables, that but one syllable could be seen at one time through the screen.

The experiments were made with the assistance of seven competent subjects, five men and two women including the writer. With one exception, these subjects were all unacquainted with the purpose of the experiment. Before the tests were finished, each had discovered that rhythm was involved in the reading, but no one had any idea that the aim of the investigation was to determine the extent to which irregularity among intervals might exist and rhythm still be maintained. The experiments lasted 25 days for each subject, and were conducted at the same hour every day.

The plan for daily work, after the preliminary days upon which series of syllables at regular intervals were read and learned, was as follows :

First Day—Dec. 5, 1900, 8.30 A. M. First paper.

Rotation of Cylinder, 9 seconds. Controlled immediately before and after every test.

Conductor, M. K. S. Subject, Mr. A.

1. Reading first Series (S_1)—20 Repetitions.
2. Reading second Series (S_2)—20 Repetitions.

Second Day—Dec. 6, . 8.30 A. M. First paper.

Rotation of Cylinder, 9 seconds.

1. (a) Reading of S_2 until learned. Repetitions necessary, 25.
(b) Test. Reproduction S_2 (*Treffer*). Syllables reproduced, 4.
2. (a) Reading of S_1 until learned. Repetitions necessary, 20.
(b) Test. Reproduction S_1 (oral reproduction of whole series).

Syllables reproduced, 12.

Pause 2 minutes.

Second Paper.

3. Reading of S_3 —20 Repetitions.
4. Reading of S_4 —20 Repetitions.

The work for the remaining days was similar to that for the second day. With four subjects this plan was pursued without change. With the other three subjects, the only deviation was that each person was tested for a reproduction every day directly after the reading of each new series (20 Repetitions). The 20 repetitions were divided into two groups, with a pause of 30 seconds after the first ten. This procedure had nothing to do with rhythm, but was a means for resting the reader's eyes, and was a help in learning the syllables.

At the close of each experiment every day, the results were noted, including the introspections of the subject, as well as the observations of the conductor.

The memory test known as the "*Treffer*" was conducted as follows. Through an opening in the screen, a single syllable of the series which had been learned was presented. The sub-

ject was required to mention the syllable which came next in the series. Thus six syllables were presented, as a means to the reproduction of the other six syllables of the series. The order of presentation was systematically varied, so that the student never knew what part of the series would be presented.¹ The memory tests, though systematically carried out, had, of course, nothing to do with the rhythm, except that they gave greater purpose to the reading, and directed the reader's attention away from the rhythm.

The rhythm resulting from the reading was recorded as it was judged by the conductor. A certain control of this judgment was attempted by means of separate kymograph records of the reading of each subject, but the main reliance is placed upon the subjective judgment of the conductor of the experiment. In a strict sense, therefore, the results might be supposed to be influenced by the rhythmic tendencies of both the subject and the experimenter, but the kymograms give sufficient ground for thinking that the conductor's judgments were in the main correct.²

The following table, covering the tests of a few days with a single subject, will give some idea of the observations made and the results with reference to rhythm.

With one exception, to be mentioned later, the experiment for which a part of the record is given below, was the least satisfactory, in regard to rhythm, of any that were made. Reading from the rotating cylinder was hard for Mr. K. The motion confused his vision, while the pronunciation of meaningless syllables was very difficult. At almost every test, the effort involved was so great as to be disagreeable. Notwithstanding these difficulties, a constant effort to make unequal intervals equal was to be observed. After some facility had been attained, rhythm always appeared. With the perception of rhythm came pleasant feeling, and a sensation of relief. The learning of the four series on one paper required for Mr. K. from 30 to

¹Müller u. Schumann: Beiträge zur Untersuchung des Gedächtnisses, Leipzig, 1893.

²These kymograms were secured in the following way: After reading one of the series, another paper with the same spacings, but containing other syllables, was put on the brass cylinder which rotated as usual. After some repetitions for practice, the subject read the syllables into a small funnel connected by rubber tubing with a tambour. The vibrations of the elastic membrane of the tambour were conveyed to a pen which inscribed the movements on a paper on a second kymograph cylinder. The resulting kymograms showed the reader's groupings of the syllables. In every case, the kymogram showed a rhythmic grouping which upon the whole agreed with the impression received by the conductor at the regular reading. Owing to a difficulty in finding suitable explosive consonants for the beginning and end of the syllables that were read into the funnel, the kymograms were not always easy to decipher in detail, which probably accounts for some at least of such differences as appeared between the conductor's record and those of the kymograph.

Date.	Days.	Paper.	Series.	Repetition preparation.	Repetition for reproduction.	RHYTHM.	REMARKS,
Dec. 13.	1	1	S1	20		— — — — — — — — — — — —	
			S2	20		— — — — — — — — — — — —	
Dec. 14.	2	1	S2		45		Rhythm perceptible, but so irregular that it could not be indicated.
			S1	25			
			S3	20			Same true of new Series 3 and 4.
			S4	20			
Dec. 17.	3	1	S4		25	— — — — — — — — — — — —	Iambic measure clear.
			S3	25		— — — — — — — — — — — —	Trochaic. Subject tried to group in 3s and 4s, failed.
			S2	20			Grouped in 3s without special accent.
			S1	20			Grouped in 4s. Rhythm not to be indicated.
Dec. 18.	4	2	S1		30	— — — — — — — — — — — —	
			S2	30		— — — — — — — — — — — —	
			S3	20			Irregular. Rhythm not to be indicated.
			S4	20			Irregular. Rhythm not to be indicated.
Dec. 19.	5	2	S4		10	— — — — — — — — — — — —	} Rhythm irregular but with a tendency to Iambics.
			S3	20		— — — — — — — — — — — —	
			S1	20		— — — — — — — — — — — —	} A strong effort to secure regularity, giving a certain rhythm.
			S2	20		— — — — — — — — — — — —	
Dec. 21	6	3	S2		16	— — — — — — — — — — — —	} Iambic and anapaest clear.
			S1	15		— — — — — — — — — — — —	
			S4	20		— — — — — — — — — — — —	} Though this is the measure, the Rhythm was hardly perceptible.
			S3	20		— — — — — — — — — — — —	
Dec. 22.	7	3	S3		12	— — — — — — — — — — — —	} Somewhat iambic, but very irregular.
			S4	15		— — — — — — — — — — — —	
			S1	20		— — — — — — — — — — — —	} Trochaics somewhat marked.
			S2	20		— — — — — — — — — — — —	
Dec. 24.	8	4	S2		10	— — — — — — — — — — — —	} About the same as above. Trochaics marked.
			S1	10		— — — — — — — — — — — —	
			S4	20		— — — — — — — — — — — —	} Much as before.
			S3	20		— — — — — — — — — — — —	
Jan. 3.	9	4	S3		15	— — — — — — — — — — — —	} Iambics somewhat marked.
			S4	15		— — — — — — — — — — — —	
			S1	20		— — — — — — — — — — — —	} Indefinite, but Rhythm perceptible.
			S2	20		— — — — — — — — — — — —	

60 repetitions of each series. The subject preferred to group the syllables in threes, but was seldom able to do so. Upon the whole the trochaic grouping predominated. With other subjects the same tests gave different results.

From the beginning Mr. M. secured a distinct iambic measure. To do this he was obliged to make many modifications, so that the effect was markedly different from the ordinary verse measure. Where the similarity to verse rhythm was lost, a resemblance to a dancing movement was to be observed. From 23 to 35 repetitions were necessary for the learning of a series. With one exception, this was the smallest number of repetitions made by any subject.

Mrs. K. also read in distinct iambic measure. In order to equalize the intervals, she memorized certain syllables at the first or second reading, and then brought them in as she needed them to make the measure. The resulting iambic measure was as follows:

| ˘ ˘ | ˘ ˘ | ˘ ˘ | ˘ ˘ | ˘ ˘ | ˘ ˘ |

This test indicated that the intervals between the members of a group and the intervals between the groups themselves are very different matters. If either set of intervals be equalized, the rhythm is marked. If both sets be equalized the rhythm is smoother, but not necessarily more musical. From the inequalities of the time intervals Mrs. K. inferred the inequalities of the space intervals. By reason of the constant rhythm maintained, Mrs. K. learned each series more quickly than any of the other subjects.

Another subject, Mr. T., found the reading of the same syllables very difficult. He reported a "feeling of strain" in trying to catch the passing syllables. The unequal intervals were the source of some unpleasant feeling which the subject did not trace to the right source. He thought that the number of syllables was not the same in all the series. Although he read throughout in trochaic measure, his manner of reading varied greatly. His measures were characterized by pauses and shades of accent that come under no known rules of rhythm. To him, learning the syllables was very difficult, and very unpleasant. He resented the demand on his attention.

Mr. L. found the same syllables easy. He read constantly in iambic measure. He knew nothing of the purpose of the experiments, yet he constantly talked of rhythm. He found the irregularities very amusing. The rate of rotation (9 seconds) was too slow for him, so that he made many fantastic associations.

Another subject, Mr. A., secured a distinct rhythm by a procedure different from that of any other person. He grouped in twos and threes, often securing the accent by substituting time for stress. He was always successful in securing an adaptation of sound and time to the space intervals of the series. To him, the difficulties arising from unequal intervals were entirely subjective. He believed that he voluntarily created the effects. The measure secured was agreeable, and amusing, and aided in very accurate memory work. The subject said, "The rhythm is divided into twelve unequal parts, and the task is to make those parts equal. Yet it is a time and not a space equality. A new arrangement causes a feeling of uncertainty, a slight annoyance at not being able to run at once into an old, or indeed into any rhythm. This somewhat unpleasant feeling is tempered by a curiosity as to what can be done with the rhythm. When one cannot read the new series as the last was read, uncertainty and annoyance follow. After some effort, the rhythm settles itself. Satisfaction arises and things become easy." In reading the tenth paper, the first eight repetitions gave no satisfactory rhythm. Finally, something like the following was secured | — | — | ˘ ˘ — | — | — | — ˘ ˘ | ˘ — | .

of an inch to ten inches. This variation extended to the different series, no two of which were arranged in the same way. The syllables, similar in construction to those used in the previous tests, were printed instead of written. Blank paper four feet in length was attached to each end of the long paper. This strip, now fifty feet long, was rolled tightly on the cylinder. The latter being set in motion, four feet of blank paper first rolled off; then the reading of separated syllables through an opening in the screen began and continued until the whole fifty feet had been run off. By the time the whole strip had been run off, one series had been read twenty times. The paper being readjusted, the next series was read in the same manner as the preceding one. Two new series were read each day, and the learning was tested as before.

The point was to find whether, with the increased and un-repeated inequalities, the subject would still read rhythmically. Of the set of subjects who served in the earlier tests, six were also employed for the new ones. In addition four new subjects were selected, who had had no experience in work of this kind.

The results will be sufficiently clear from the individual reports:

Mr. K., who had found the previous work sufficiently trying, found this confusing, annoying, and very difficult. Towards the close, some signs of rhythm were perceived. The learning was very imperfect.

As in the previous tests, Mr. M. read in distinct iambs, and learned easily.

Mrs. K., as before, read in strong iambs, and learned quickly.

Mr. S. found more difficulties than before, and could not learn until something like trochaics was secured.

Mr. A. found more difficulty than in the previous work, but after securing an anapaest movement, he learned readily.

On the first day, Miss S. had a distinct sensation of rhythm. Later she seemed to read in iambic, anapaest, or dactylic movements.

Mr. H. (one of the new subjects) had very little sensation of rhythm, though he finally grouped in twos. He could not learn the syllables, but thought that he could have done so by singing them.

In reading the same series, Mr. H.'s son, a boy of thirteen, read in iambs at once. This subject knew nothing about the unequal intervals, but was annoyed by "something that broke the beat," so that he could "hardly get the syllables back into order." He said "it was like men stepping. The band played, and something came and broke the march. Several men kept time. They broke step suddenly." Toward the close of the tests, this boy sang the syllables in dactyls

and kept time very well. The singing was quite spontaneous. This lad played his way through the tests, and enjoyed the reading greatly.

Another of the new subjects grouped the syllables in threes by beating with her finger. Her perception of rhythm was very slight.

The last of these subjects, Mr. S., swayed his shoulders to some rhythmic movement which he located in the screen. Otherwise he had a very slight perception of rhythm.

III.

In summing up the results of this investigation into the limits of the inequality and irregularity of intervals in connection with the rhythms of speech, it may be stated that each subject tried to equalize unequal intervals. Of eleven subjects, nine had a distinct impression of rhythm resulting from a greater or less equalizing of the intervals. The other two subjects had but vague impressions of rhythm.

Some of the devices for securing equality were as follows:

1. Certain syllables were memorized at the first reading. Later, these syllables were spoken before they appeared at the opening in the screen, or they were held back and spoken after they had passed. This hastening or delaying of the syllable was according to the need of the individual.

2. Manner of articulating became a factor in equalizing intervals. Quick, distinct utterance of a vowel lengthened the interval, while holding it with a glide shortened the interval.

5. Sometimes the suspension of the rhythm had the effect of equalizing the intervals. This differed distinctly from a pause between feet.

6. Beating time with hand or foot while reading was an important factor in securing and maintaining equal intervals.

7. Repetition of the series was a great aid in securing regularity and equality among intervals. It was also a means of developing an apprehension of rhythm. The equality was not determined by the shortest interval, but by some one interval to which the others could be the most easily adapted.

GENERAL OBSERVATIONS.

Excepting Mr. H., who had no theories regarding rhythm, the subjects all believed that without orderly speech movements, and approximately equal intervals, regularly succeeding one another, the learning of a series of syllables was impossible. When the apprehension of rhythm accompanied such movements, the best condition for learning existed.

Some of the subjects appreciated the importance of keeping one rhythm. Mr. M. and Mrs. K. established an iambic rhythm, and maintained it throughout their work. These two learned with much greater ease than those who showed greater variations in rhythm.

After the pleasant feeling resulting from rhythm had been once experienced, it came to be regarded as very important in learning, while the unpleasant feeling resulting from irregularity and confusion was an absolute hindrance to the same work.

Although the learning of the syllables was the chief aim of all but one of the subjects, the conscious effort was directed mainly to the equalization of the intervals. After a rhythm was established, its tendency to persist and to dominate the mental state was marked. So long as a rhythm remained unchanged, the substitution of one letter for another, at the beginning of a syllable, was almost impossible. A syllable mispronounced at the beginning of the work must remain so throughout the test. Also the rhythm of one series had a tendency to dominate the next series. A total change of intervals did not always insure a change of rhythm. This was especially shown in the work of Mr. M. and Mrs. K.

In these tests, both primitive (single) and complex rhythms were developed. As a rule the primitive rhythm when developed ran through the whole series, but sometimes, owing to the inequalities of the intervals, in the same series, a curious mingling of simple and complex rhythms might occur.

In reading with primitive rhythm, no stress is placed on the syllables. The rhythmic expression is secured by the management of the intervals between the syllables. The subject realized the monotony of this reading, and as soon as facility was secured, made an effort to avoid it. The first reaction against "level" reading was shown in a tendency to accent every syllable, a procedure only less tedious than the one it supplanted. Just here arose the necessity for grouping. The limitations of respiration made it impossible to accent more than three syllables with one breath. A strong accent on each member of a group involved still more frequent inhalations of breath. The untrained subject was obliged to take a breath at the end of every two or three syllables. These peculiarities of breathing are shown clearly on the kymograms.

The next step from a simple towards a more complex rhythm consisted in grouping, and placing an equally strong accent on each member of the group. After some repetitions, the subjects (except Mr. H.) all showed a tendency to accent some one member of a group, especially, so that the effect of verse rhythm was secured. Of seven subjects who served for the regular experiments, four grouped mostly in iambs, and three mostly in trochaics. In the extra tests, only the youngest of the new subjects read in iambic measure. Among the subjects for the regular tests, two read exclusively in iambs, and one nearly always in trochaics. The other subjects read more or less in dactyls or anapaests, though they seemed to prefer iambs or trochaics.

The exigencies of the irregular arrangement often made necessary a grouping that, though rhythmic, belonged to no one of the four-verse rhythms. At times three of the four typical measures were combined, while at other times, the reading involved one or two of the regular measures, together with groups of evenly accented syllables, and even with isolated members strongly accented. Often, while the conventional group was preserved, the rhythmic effect was dominated by the single syllables. In three cases, the rhythm was like that of a dancing movement.

The musical effect of the anapaestic and dactylic measures was greater than that of the iambs, and trochaics. With the three-part measures, the learning of the series was no more difficult than with the two part measures, but with the former the reproduction of syllables—after an interval—was much less certain than with the latter.